Logon

*** It is now 2/11/2009 12:00:43 PM ***

Welcome to DialogLink - Version 5
Revolutionize the Way You Work!

New on Dialog

Order Patent and Trademark File Histories Through Dialog

Thomson File Histories are now available directly through *Dialog*. Combined with the comprehensive patent and trademark information on *Dialog*, file histories give you the most complete view of a patent or trademark and its history in one place. When searching in the following patent and trademark databases, a link to an online order form is displayed in your search results, saving you time in obtaining the file histories you need.

Thomson File Histories are available from the following *Dialog* databases:

- CLAIMS/Current Patent Legal Status (File 123)
- CLAIMS/U.S. Patents (File 340)
- Chinese Patent Abstracts in English (File 344)
- Derwent Patents Citation Index (File 342)
- Derwent World Patents Index (for users in Japan) (File 352)
- Derwent World Patents Index First View (File 331)
- Derwent World Patents Index (File 351)
- Derwent World Patents Index (File 350)
- Ei EnCompassPat (File 353)
- European Patents Fulltext (File 348)
- French Patents (File 371)
- German Patents Fulltext (File 324)
- IMS Patent Focus (File 447, 947)
- INPADOC/Family and Legal Status (File 345)
- JAPIO - Patent Abstracts of Japan (File 347)
- LitAlert (File 670)
- U.S. Patents Fulltext (1971-1975) (File 652)

- U.S. Patents Fulltext (1976-present) (File 654)
- WIPO/PCT Patents Fulltext (File 349)
- TRADEMARKSCAN - U.S. Federal (File 226)

DialogLink 5 Release Notes
New features available in the latest release of DialogLink 5 (August 2006)

- Ability to resize images for easier incorporation into DialogLink Reports
- New settings allow users to be prompted to save Dialog search sessions in the format of their choice (Microsoft Word, RTF, PDF, HTML, or TEXT)
- Ability to set up Dialog Alerts by Chemical Structures and the addition of Index Chemicus as a structure searchable database
- Support for connections to STN Germany and STN Japan services

Show Preferences for details

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? Help Log On Msg
           *** ANNOUNCEMENTS ***
                  ***
*** FREE FILE OF THE MONTH: World News Connection (WNC), FILE #985
Each month Dialog offers an opportunity to try out new or
unfamiliar sources by offering $100 of free searching (either
DialUnits or connect time) in one specific file. Output and
Alerts charges are not included. For more details visit:
http://www.dialog.com/freefile/ and then take a moment to get
familiar with another great Dialog resource.

*** "Thomson File Histories" are now available directly through Dialog
in selected patent and trademark files.  Combined with the
comprehensive patent and trademark information on Dialog, file
histories give you the most complete view of a patent or trademark
and its history in one place. When searching in one of the patent
and trademark databases, a link to an online order form is displayed
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in your search results, saving you time in obtaining the file
histories you need. See HELP FILEHIST for more information about
how to use the link and a list of files that contain the link.

NEW FILE
***File 651, TRADEMARKSCAN(R) - China. See HELP NEWS 651 for details.

RESUMED UPDATING
***File 523, D&B European Financial Records
                    ***
RELOADS COMPLETED
***Files 154&155, MEDLINE(R)
***File 227, TRADEMARKSCAN(R) - Community Trademarks
                    ***
FILES RENAMED
***File 321, PLASPEC now known as Plastic Properties Database
                    ***
FILES REMOVED
***File 388,PEDS: Defense Program Summaries
***File 588,DMS-FI Contract Awards

>>>For the latest news about Dialog products, services, content<<<
>>>and events, please visit What's New from Dialog at   <<<
>>>http://www.dialog.com/whatsnew/. You can find news about   <<<
>>>a specific database by entering HELP NEWS <file number>.   <<<

? Help Off Line
* * *
Connecting to Scott Jarrett - Dialog - 276702
Connected to Dialog via SMS002232352

? b 411
> Set Files all

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> Select milestone? and (project? or material?) (n2) (manag?? or plan??) and ((forecast??
or predict?? or project??) (n2) (supplies or materials or item or equipment)) and
(telecom?? or bellsouth?) not py>2000

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2 databases have items, of 512 searched.

Hits	File	Name
1	610	Business Wire 1999-2009/Feb 11
2	996	Newsroom 2000-2003

Estimated Cost Summary

Project		Client		Charge Code		Searcher		Job		Service Code	User Number
						Scott Jarrett				51	276702
Date		Time		SessionID		Subsession		Subaccount			
02/11/2009		12:34:00		169		3					
Data Base	Dial Units	Access Charge	Print Credit	Types	Prints	Report	Rank	Links	CSS	Total	
411	103.1440	303.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	303.24	
Sub Totals	103.1440	$303.24	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$303.24	

Session Totals	103.5050	$303.26		Telecom	$8.83					$312.09

```
Begin 610,996
```

[File 610] Business Wire 1999-2009/Feb 11

**File 610: File 610 now contains data from 3/99 forward. Archive data (1986-2/99) is available in File 810.*

[File 996] Newsroom 2000-2003


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SELECT milestone? and (project? or material?) (n2) (manag?? or plan??) and ((forecast??
or predict?? or project??) (n2) (supplies or materials or item or equipment)) and
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       271320   MILESTONE?
      4611018   PROJECT?
      4072278   MATERIAL?
      5734175   MANAG??
      9336102   PLAN??
       262646   (PROJECT? OR MATERIAL?)(2N)(MANAG?? OR PLAN??)
      1720084   FORECAST??
      1030612   PREDICT??
      4295824   PROJECT??
       846910   SUPPLIES
      1590499   MATERIALS
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       657870   ITEM

      2650623   EQUIPMENT

        21863   ((FORECAST?? OR PREDICT??) OR PROJECT??)(2N)(((SUPPLIES OR MATERIALS) OR
ITEM) OR EQUIPMENT)

       865260   TELECOM??

        53032   BELLSOUTH?

     46272665   PY>2000

S1          3   SELECT MILESTONE? AND (PROJECT? OR MATERIAL?) (N2) (MANAG?? OR PLAN??)
AND ((FORECAST?? OR PREDICT?? OR PROJECT??) (N2) (SUPPLIES OR MATERIALS OR ITEM OR
EQUIPMENT)) AND (TELECOM?? OR BELLSOUTH?) NOT PY>2000


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Set     Items   Description

S1          3   SELECT MILESTONE? AND (PROJECT? OR MATERIAL?) (N2) (MANAG?? OR PLAN??)
AND ((FORECAST?? OR PREDICT?? OR PROJECT??) (N2) (SUPPLIES OR MATERIALS OR ITEM OR
EQUIPMENT)) AND (TELECOM?? OR BELLSOUTH?) NOT PY>2000


?  t s2/3.k/all

>>>E:  Set 2 does not exist


?  t s1/3,k/all
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1/3,K/1 (Item 1 from file: 610)
Business Wire

00398363 20001031305B5677 (USE FORMAT 7 FOR FULLTEXT)
RadioWallStreet.com: Roth Capital and the New Economy

Business Wire
Tuesday , October 31, 2000 10:55 EST
Journal Code: BW Language: ENGLISH Record Type: FULLTEXT Document Type: NEWSWIRE
Word Count: 4,259

Text:

```
...predetermined billing schedule over the course of the engagement. We do
not
perform work under milestone-based billing schedules. We recognize
revenues
from fixed-price contracts on the percentage-of-completion...

...Amounts billed before we
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perform services are classified as deferred revenue. We bill time-and-materials projects twice per month on the 15th and last day of each month. We recognize time...included in this report, regarding our strategy, future operations, financial position, estimated revenues or losses, projected costs, prospects, plans and objectives of management are forward-looking statements. When used in this registration statement, the...been accounted for under the percentage-of-completion basis, based upon achievement of specifically identifiable milestones.
COST OF REVENUE

Cost of revenue includes labor, materials and overhead expenses incurred in the...2000 (BUSINESS WIRE) -- On this week's edition of Roth Capital and the New Economy, Telecom Analyst Glenn Powers will give insight into the telecom sector.

He will comment on: Metro One Telecommunications (Nasdaq:MTON). This event will be broadcast...

1/3,K/2 (Item 1 from file: 996)
Newsroom 2000-2003

0157511757 157V0CHE
RadioWallStreet.com: Roth Capital and the New Economy

BUSINESS WIRE
Tuesday , October 31, 2000
Journal Code: ADZA Language: ENGLISH Record Type: Fulltext
Document Type: Newswire
Word Count: 4,403

Text:

...predetermined billing schedule over the course of the engagement. We do not perform work under milestone-based billing schedules. We recognize revenues from fixed-price contracts on the percentage-of-completion...

...Amounts billed before we perform services are classified as deferred revenue. We bill time-and-materials projects twice per month on the 15th and last day of each month. We recognize time...included in this report, regarding our strategy, future operations, financial position,

estimated revenues or losses, projected costs, prospects, plans and objectives of management are forward-looking statements. When used in this registration statement, the...been accounted for under the percentage-of-completion basis, based upon achievement of specifically identifiable milestones.

COST OF REVENUE

Cost of revenue includes labor, materials and overhead expenses incurred in the...2000 (BUSINESS WIRE) -- On this week's edition of Roth Capital and the New Economy, Telecom Analyst Glenn Powers will give insight into the telecom sector.

He will comment on: Metro One Telecommunications (Nasdaq:MTON). This event will be broadcast...

1/3,K/3 (Item 2 from file: 996)
Newsroom 2000-2003

0047038999 150Y162Q
Nuclear power in Korea

Anonymous
Energy Markets , v 5 , n 3 , p 59
Friday , March 31, 2000
Journal Code: AMJX Language: ENGLISH Record Type: Fulltext
Document Type: Trade Journal ISSN: 1090-8706
Word Count: 1,751

Text:

...Many of these components were manufactured in Korea for Wolsong Units 2, 3 and 4.

Milestones

A Reactor's Schedule from Groundbreaking To Commercial Operation (Wolsong 3)

There is a long...

...would supply equipment for the nuclear steam plant. Daewoo, another Korean company, also would supply equipment for the project.

More immediately, Korea is involved in the Candu project at Qinshan, China, where two Candu...

...providing commissioning training and construction assistance, and Hanjung is supplying equipment for the nuclear steam plant. The Qinshan project represents Korea's first export of nuclear equipment.

Korea is continuing to make clean, reliable...

Company Names: NUCLEAR ENGINEERING LTD; ATOMIC ENERGY OF CANADA LTD; INTEC TELECOM SYSTEMS PLC; HANARO CORP; KOREA POWER ENGINEERING CO INC; KOREA ELECTRIC POWER CORP; DAEWOO CORP
Dialog Update Date:

? b 411

Estimated Cost Summary

Project		Client		Charge Code		Searcher		Job		Service Code	User Number
						Scott Jarrett				51	276702
Date		Time		SessionID		Subsession		Subaccount			
02/11/2009		12:38:09		169		5					
Data Base	Dial Units	Access Charge	Print Credit	Types	Prints	Report	Rank	Links	CSS	Total	
610	0.5210	0.54	0.00	1.40	0.00	0.00	0.00	0.00	0.00	1.94	
996	8.5780	37.74	0.00	3.14	0.00	0.00	0.00	0.00	0.00	40.88	
Sub Totals	9.0990	$38.28	$0.00	$4.54	$0.00	$0.00	$0.00	$0.00	$0.00	$42.82	
Session Totals	112.9500	$350.70		Telecom	$1.07					$356.31	

> Set Files all

> Select (material? (n2) management) and (project (n2) management) and (telecom?? or infrastructur?? or construction) and milestone? not py>2001

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29 databases have items, of 512 searched.

Hits	File	Name
1	9	Business & Industry(R) Jul/1994-2009/Feb 09
3	13	BAMP 2009/Feb 10
24	15	ABI/Inform(R) 1971-2009/Feb 09
13	16	Gale Group PROMT(R) 1990-2009/Jan 22
9	20	Dialog Global Reporter 1997-2009/Feb 11
2	47	Gale Group Magazine DB(TM) 1959-2009/Feb 02
2	75	TGG Management Contents(R) 86-2009/Jan W2
4	88	Gale Group Business A.R.T.S. 1976-2009/Feb 09
1	120	U.S. Copyrights 1978-2009/Feb 10
19	148	Gale Group Trade & Industry DB 1976-2009/Jan 21
11	180	Federal Register 19852009/Feb 11
2	194	FBODaily 1982/Dec-2008/Aug
3	262	CBCA Fulltext 1982-2009/Feb W2
3	275	Gale Group Computer DB(TM) 1983-2009/Jan 16
14	349	PCT FULLTEXT 1979-2009/UB=20090108|UT=20090101
3	484	Periodical Abs Plustext 1986-2009/Jan W1
10	485	Accounting & Tax DB 1971-2009/Jan W4
1	542	SEC Online(TM) 10-K Reports 1997/Sep W3
2	610	Business Wire 1999-2009/Feb 11
1	613	PR Newswire 1999-2009/Feb 11
1	618	Xinhua News 1999-2009/Feb 11
1	619	Asia Intelligence Wire 1995-2009/Feb 10
6	621	Gale Group New Prod.Annou.(R) 1985-2009/Jan 08
1	636	Gale Group Newsletter DB(TM) 1987-2009/Jan 21
6	649	Gale Group Newswire ASAP(TM) 2009/Jan 09
20	660	Federal News Service 1991-2002/Jul 02
3	810	Business Wire 1986-1999/Feb 28

2	813	PR Newswire 1987-1999/Apr 30
14	996	Newsroom 2000-2003

Estimated Cost Summary

Project		Client		Charge Code		Searcher		Job		Service Code	User Number
						Scott Jarrett				51	276702
Date		Time		SessionID		Subsession		Subaccount			
02/11/2009		13:01:38		169		6					
Data Base	Dial Units	Access Charge	Print Credit	Types	Prints	Report	Rank	Links	CSS	Total	
411	75.5050	221.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	221.99	
Sub Totals	75.5050	$221.99	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$221.99	
Session Totals	188.5710	$578.83		Telecom	$6.24					$585.05	

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Begin
9,13,15,16,20,47,75,88,120,148,180,194,262,275,349,484,485,542,610,613,618,619,621,636,64
9,660,810,813,996
```

[File 120] U.S. Copyrights 1978-2009/Feb 10

File 120: As of February 18, 2008, the file is updating regularly and is current.

[File 148] Gale Group Trade & Industry DB 1976-2009/Jan 21

File 148: The CURRENT feature is not working in File 148. See HELP NEWS148.

[File 180] Federal Register 19852009/Feb 11

[File 194] FBODaily 1982/Dec-2008/Aug

[File 262] CBCA Fulltext 1982-2009/Feb W2

[File 275] Gale Group Computer DB(TM) 1983-2009/Jan 16

[File 349] PCT FULLTEXT 1979-2009/UB=20090108|UT=20090101

[File 484] Periodical Abs Plustext 1986-2009/Jan W1

[File 485] Accounting & Tax DB 1971-2009/Jan W4

[File 542] SEC Online(TM) 10-K Reports 1997/Sep W3

File 542: This file is closed.

[File 610] Business Wire 1999-2009/Feb 11

File 610: File 610 now contains data from 3/99 forward. Archive data (1986-2/99) is available in File 810.

[File 613] PR Newswire 1999-2009/Feb 11

File 613: File 613 now contains data from 5/99 forward. Archive data (1987-4/99) is available in File 813.

[File 618] Xinhua News 1999-2009/Feb 11

File 618: File 618 now contains data from 6/99 forward. Archive data (1996-5/99) is available in File 818.

[File 619] Asia Intelligence Wire 1995-2009/Feb 10

[File 621] Gale Group New Prod.Annou.(R) 1985-2009/Jan 08

[File 636] Gale Group Newsletter DB(TM) 1987-2009/Jan 21

[File 649] Gale Group Newswire ASAP(TM) 2009/Jan 09

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>>>W:  One or more prefixes are unsupported

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     21739843   MATERIAL?

     35236414   MANAGEMENT

       226137   MATERIAL?(2N)MANAGEMENT

     13920827   PROJECT

     35236414   MANAGEMENT

       674670   PROJECT(2N)MANAGEMENT

      4458289   TELECOM??

      7240649   INFRASTRUCTUR??

     11348688   CONSTRUCTION

      1513882   MILESTONE?

    129085730   PY>2001

S1        182   SELECT (MATERIAL? (N2) MANAGEMENT) AND (PROJECT (N2) MANAGEMENT) AND
(TELECOM?? OR INFRASTRUCTUR?? OR CONSTRUCTION) AND MILESTONE? NOT PY>2001


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>>>W:  Duplicate detection is not supported for File 120.

Duplicate detection is not supported for File 349.

Duplicate detection is not supported for File 542.

Duplicate detection is not supported for File 660.

Records from unsupported files will be retained in the RD set.

S2        119   RD  (UNIQUE ITEMS)


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Set     Items   Description

S1        182   SELECT (MATERIAL? (N2) MANAGEMENT) AND (PROJECT (N2) MANAGEMENT) AND
(TELECOM?? OR INFRASTRUCTUR?? OR CONSTRUCTION) AND MILESTONE? NOT PY>2001
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S2         119   RD  (unique items)


?  s s2 and (telecom?? or bellsouth)
           119   S2
       4458289   TELECOM??
        284145   BELLSOUTH
S3           5   S S2 AND (TELECOM?? OR BELLSOUTH)


?  t s3/ti/all
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3/106/1 (Item 1 from file: 349)
PCT FULLTEXT

Country	Number	Kind	Date

3/106/2 (Item 2 from file: 349)
PCT FULLTEXT

Country	Number	Kind	Date

3/106/3 (Item 3 from file: 349)
PCT FULLTEXT

Country	Number	Kind	Date

3/TI/4 (Item 1 from file: 485)
Accounting & Tax DB

Using reference models within the enterprise resource planning lifecycle

3/TI/5 (Item 1 from file: 619)
Asia Intelligence Wire

SPECIAL REPORT: ERP

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          119   S2
     12942058   LEAD
     59063018   TIME
       115548   LEAD(W)TIME
S4         16   S S2 AND (LEAD () TIME)

?  t s4/ti/all
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4/TI/1 (Item 1 from file: 15)
ABI/Inform(R)

Just-in-time management in precast concrete construction: A survey of the readiness of main contractors in Singapore

4/TI/2 (Item 2 from file: 15)
ABI/Inform(R)

Re-engineering materials management: A case study on an Indian refinery

4/TI/3 (Item 3 from file: 15)
ABI/Inform(R)

Service logistics: An introduction

4/TI/4 (Item 4 from file: 15)
ABI/Inform(R)

Measuring and benchmarking materials management effectiveness

4/TI/5 (Item 1 from file: 75)
TGG Management Contents(R)

The Chief Executive Guide to EBS.(includes related articles)(Enterprise Business Solutions)

4/TI/6 (Item 1 from file: 148)
Gale Group Trade & Industry DB

Greenfield decommissioning at Shippingport: cost management and experience. (Special Nuclear Decommissioning Issue)

4/TI/7 (Item 1 from file: 180)
Federal Register

Super Notice of Funding Availability (SuperNOFA) for HUD's Housing, Community Development and Empowerment Programs and Section 8 Housing Voucher Assistance for Fiscal Year 2001

4/TI/8 (Item 2 from file: 180)
Federal Register

Introduction to The Regulatory Plan and the Unified Agenda of Federal Regulatory and Deregulatory Actions

4/TI/9 (Item 3 from file: 180)
Federal Register

Lead-Based Paint: Interim Guidelines for Hazard Identification and Abatement in Public and Indian Housing

4/TI/10 (Item 1 from file: 262)
CBCA Fulltext

Plan without borders: it's a far cry from Canada to Qatar, but the basics of good project management are pretty much the same anywhere

4/106/11 (Item 1 from file: 349)
PCT FULLTEXT

	Country	Number	Kind	Date

4/106/12 (Item 2 from file: 349)
PCT FULLTEXT

	Country	Number	Kind	Date

4/106/13 (Item 3 from file: 349)
PCT FULLTEXT

Country	Number	Kind	Date

4/106/14 (Item 4 from file: 349)
PCT FULLTEXT

Country	Number	Kind	Date

4/106/15 (Item 5 from file: 349)
PCT FULLTEXT

Country	Number	Kind	Date

4/TI/16 (Item 1 from file: 660)
Federal News Service

Title: HEARING OF THE ENERGY AND WATER DEVELOPMENT SUBCOMMITTEE OF THE SENATE APPROPRIATIONS COMMITTEE
SUBJECT: FY 2002 BUDGET REQUEST FOR THE DEPARTMENT OF ENERGY
CHAIRED BY: REPRESENTATIVE PETE DOMENICI (R-NM)
WITNESSES:
CAROLYN HUNTOON, ASSISTANT SECRETARY, ENVIRONMENTAL MANAGEMENT, DEPARTMENT OF ENERGY;
LAKE BARRETT, DIRECTOR, OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT, DEPARTMENT OF ENERGY
LOCATION: 138 DIRKSEN SENATE OFFICE BUILDING, WASHINGTON, D.C.
TIME: 2:30 P.M., EDT DATE: TUESDAY, MAY 15, 2001

```
?  t s4/3,k/4
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4/3,K/4 (Item 4 from file: 15)
ABI/Inform(R)

00905837 95-55229
Measuring and benchmarking materials management effectiveness

Plemmons, James K; Bell, Lansford C
American Association of Cost Engineers Transactions 1994 Transactions pp: MAT2.1-MAT2.9
1994
ISSN: 0065-7158 Journal Code: AEE
Word Count: 4041
Measuring and benchmarking materials management effectiveness

Abstract:

Quantitatively measuring the benefit of new concepts and technologies presents a challenge to construction industry professionals. Measurements are key to controlling, managing, and improving any work process. Applying standard measures within the construction materials management process allows current project performance to be benchmarked against past performance, other projects, and possibly...

...evaluates process performance by making a comparison between actual results and planned or target results. Materials management, being a results-oriented process, offers a good candidate for effectiveness measures. The results of...

...presented. The research proposes to determine the significant or key effectiveness measures of the industrial construction materials management process that might be benchmarked within the construction industry.

Text:

Quantitatively measuring the benefit of new concepts and technologies presents a challenge to construction industry professionals. Measurements are key to controlling, managing, and improving any work process. Without measurements...

...integrated computer systems, bar coding, and electronic data interchange (EDI). Applying standard measures within the construction materials management process allows current project performance to be benchmarked against past performance, other projects, and possibly...

...Process effectiveness is how well the process meets the requirements of its end customer [3]. Materials management, being a results-oriented process, offers a good candidate for effectiveness measures. In the construction industry, materials and equipment are

specified, obtained, and made available to meet the requirements of construction operations, the process customer.

The importance of measuring the degree to which construction's requirements are met by the materials management process identifies the need for applying a results based, or effectiveness, measurement system. Also, measuring the degree to which the materials management process meets the needs and requirements of construction operations allows the impact of process changes to be measured.

The benefits of process improvements...

...into the application of technology and measurement techniques. Adapting existing measurement techniques to the industrial construction environment provides the tools for benchmarking performance measures across functional, project, and organizational boundaries. Benchmarking...

...following business-related problem: What are the significant, or key, effectiveness measures of the industrial construction materials management process that might be benchmarked within the construction industry?

In answering this question, the aim is to provide the construction industry with appropriate indication of performance for the materials management process that are objectively measurable and yield a hierarchy of measures leading to an overall...

...The research has four specific objectives:
* develop industry generic flow diagrams for a typical industrial construction materials management process;

* determine measures, descriptions, units of measure, and measurement points;

* obtain industry consensus in rank...

...with industry professionals to develop a working understanding of effectiveness in relation to the industrial construction materials management process. The result will be documented measures from construction and other industries that evaluate performance of materials management, logistics, or procurement functions.

Flow Chart Development

Develop a generic process model as it applies to materials management for a typical industrial construction project.
This model provides the framework for communicating functional boundaries, communication channels for data or information, and measurement points within the system.

Initial Site Visits
Compile a representative group of materials management measures currently used within the industrial construction industry through a number of site visits and inquiries to industry professionals. The feasibility of sharing materials management benchmark data between engineering contractors and facility owners within the construction industry will be investigated. The industry professionals expressing an interest in participating in the research effort and knowledgeable in their organization's materials management process will be considered to participate on a research advisory team.

Preliminary Measures

Develop a package of representative measures associated with materials management for a typical industrial construction project. The format will include title, definition, measurement points, and illustrative graphics.

Classify Measures

A Delphi technique will be used to classify the measures of materials management effectiveness within five major categories: quality, quantity, cost, time, and availability. A pilot test will...
...measures, changes in the measurement protocol, or improved graphical samples. The objective is to obtain construction industry consensus on the measurements associated with the five categories.

Rank Ordering of Measures

Determine which measures represent the key measures of materials management effectiveness. The measures within each category will be rank ordered according to the degree to which the measure impacts the defined purpose of the materials management process. A weighted value of importance will be assigned for each measure. Secondary criteria will...

...effectiveness;

* industry specific relationships among the measures;

* significant differences between the contracting parties (owner, constructor, construction manager); and

* influence of contract type upon the relative importance.

Propose a Benchmarking Mechanism
Based on the input from construction industry professionals, propose a mechanism to communicate effectiveness measures within the construction industry. The preliminary results will be reviewed by a selected group of industry professionals, hereafter...

...research advisory team, and the recommendations incorporated into a proposed benchmarking action plan for the construction industry.

THE MATERIALS MANAGEMENT PROCESS

Materials management is the planning and controlling of all necessary efforts to ensure the correct quality and...

...cost, and are available when needed [2]. As determined from the literature review, the basic materials management process for a typical industrial construction project is as shown in Figure 1. This functional process model provides a common framework for communicating in common terms within the construction industry. Consequently, the common terminology allows benchmarking partners to communicate key measures of materials management effectiveness across project, functional, and corporate boundaries.

Process and Functional Boundaries

Viewing materials management as a process with interrelated, interdependent, and usually sequential functions provides the basis for developing...

...model. The block diagram defines the process and functional boundaries related to a typical industrial materials management process. The arrows represent the material or data flow associated with the primary and secondary...

...secondary customers, while the end boundary identifies the primary output from the process. In the materials management process, the primary output is identified as the issuing of materials to the primary customer, construction operations represented by the craft laborer.

Functional Activities

In the construction industry, the materials management process integrates the functions of planning and scheduling, material takeoff and design interface, vendor inquiry...

...function contains the activities associated with the establishment of responsibilities by material category and by materials management function, establishment of lines of communication, development of staffing and training plans, and the development of functional plans and procedures. For engineered equipment, equipment lists would be formulated, and milestone schedule, tracking mechanism, and work breakdown structure (WBS) or work packages developed while considering warranties...

...of on-site materials; and the protection and resolution of surplus materials.

Performance Measures

The materials management process exists, either as a formal or informal organizational function, to meet the requirements of construction operations, the process customer. The degree to which customers' requirements are met is a measurable...

...and price [6]. Similar terms are so referenced in key statements about the attributes of materials management in construction by Bell and Stukhart [1].

From these two sources, five major categories of effectiveness measures...

...of effectiveness measures where the nonconformance is manifested in the materials and related to the

materials management process.
Examples of material quality would include the percentages of piping spool rework and job hours per purchase order, percentage of express shipments, construction time lost due to the lack of equipment or materials, the percentage of payments made...

...reflect the degree to which the process made the materials and tagged equipment available when construction operations planned to withdraw or receive them. Examples of availability would include the percent of...

...vendor or material group, and a stockout analysis.

PROPOSED EFFECTIVENESS MEASURES

Current Status within the Construction Industry

Preliminary investigation indicates industry professionals have some notion of what they regard as effective

materials management
performance. However, the lack of common measures prevents the quantitative evaluation of the materials management process. Also, the potential savings and productivity increases associated with an effective materials management process is a commonly held but largely undocumented opinion. A review of manufacturing industry publications...

...use of standard process methodology and terminology for measuring logistics and procurement functions. However, the construction industry lacks a similar system of measurement and terminology.

Current Measures

Individuals, project organizations, and companies within the construction industry have developed a number of measures for the materials management process. Over half of the following measures are currently used by a major EPC contractor. The remainder are in

use or proposed by construction and facility owner professionals. The following measures are presented within suggested categories:

quality

* materials receiving...

...figure 4);

* vendor timeliness (by vendor or material group);

* material withdrawal request (MWR) need date lead time; and

* MWR process time. (Figure 4 omitted)

cost
* freight costs;

* expediting costs (express deliveries);

* construction time lost due to lack of equipment or materials (Figure 5); and

* warehouse safety incident...

...over an eight-week period. The trended data provide information on warehouse efforts to support construction operations. A goal of 95 percent availability would suggest a performance level for the warehouse...

...improvements (EDI, bar coding) implemented throughout the time period.

Figure 5 communicates how effectively the materials management process is performing to support construction operations. Feedback on the construction time lost due to the lack of engineered equipment or materials captures some of the impact of not meeting schedule requirements. The weekly data can be taken from construction timecards and plotted by week or as part of a six-week rolling average. The...

...out-of-limits measurement.
Figure 6 shows the percentage of material available when requested by construction for scheduled activities. (Figure 6 omitted) The weekly average for a project can be compared...

...the points are now being used within productivity and efficiency measurement systems.

Benchmarking within the construction industry requires a standard set of measurement points of project data and information. Identifying and communicating these points is possible by expanding the general materials management process diagram. For example, Figure 7 illustrates an expanded flow diagram for the purchasing function...

...channels.

To date, 40 measures have been identified and developed as representative measures of the materials management process. The majority of these measures originated from operator/owner and construction organizations. During the pilot test and research process, additional measures may be identified and added...

...and contained within the comprehensive computer systems that facilitate the execution and coordination of the materials management function would allow evaluation of the key effectiveness measures as the work progress. By tracking...

...trends provide additional justification for new technologies and management strategies. By recognizing the validity of materials management effectiveness measures across the construction industry, benchmarking communications similar to those benefiting the manufacturing, merchandising, and transportation industries would be...

...resources, and monitoring progress toward the goals.

A Benchmarking Mechanism

A benchmarking mechanism for the construction industry is possible. Suggested is a computer bulletin board system to be maintained by an organization familiar with the needs of the industry.

The Construction Industry Action Group (CIAG), formed in 1992 for the purpose of promoting EDI and related technologies in the US construction industry would be a logical choice as an organization to maintain such a system. Benchmarking...

...learned from the pilot implementation will become part of the research deliverables.
Application to the Construction Industry

The physicist Lord Kelvin once said "when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind." By benchmarking key effectiveness measures within the construction industry, management has the necessary means to improve a key business process that can make...

...2]. This ammunition for change presents a significant challenge to the competitive nature of most construction organizations.

Additional motivation to consider benchmarking is found in the criteria given to benchmarking and...

...research effort combined with the data and information gathered during four site visits to major construction projects and numerous communications with industry professionals provides the basis for the following conclusions.

* Construction managers do not apply consistent methodologies for measuring and, therefore, controlling the materials management process.

* Key measures of the materials management process exist within the industry. However, these measures are not applied uniformly, nor are they used to compare the effectiveness of the materials management process across project, functional, or organizational boundaries.

* Effectiveness of the materials management process is directly related to the people, methods, and technologies involved in performing specific, but...

...these activities impact, to some degree, how well the "right" things are done to support construction operations.

* The stability of the project environment has a positive influence upon the development and...

...term agreements with the facility owner and materials suppliers to develop quantitative measures for the materials management process. The contractor reports contract performance in terms of several specific measures. Also, these measures...

...can be reaggregated or combined with other project data to allow performance measurement of the materials management process. The majority of the measurement data appear to be available in project controls and...
...the means for applying innovative types of measures and comparisons.

Potentially significant improvement of the materials management process is possible for three reasons. First, defining key effectiveness measures in a standard format provides the common vocabulary for collaboration within the industrial construction industry. Second, collaboration is made possible by the use of a generic functional model of the materials management process. Third, process benchmarking materials management effectiveness date provides the measures to establish targets and an understanding of changes necessary to...

...paper proposes to answer the business question and develop a pilot benchmarking mechanism for the construction industry. The anticipated date when results from this research effort will be available is August 994.

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Measuring and benchmarking materials management effectiveness

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Abstract:

Quantitatively measuring the benefit of new concepts and technologies presents a challenge to construction industry professionals. Measurements are key to controlling, managing, and improving any work process. Applying standard measures within the construction materials management process allows current project performance to be benchmarked against past performance, other projects, and possibly other organizations. Effectiveness evaluates process performance by making a comparison between actual results and planned or target results. Materials management, being a results-oriented process, offers a good candidate for effectiveness measures. The results of a research effort recently initiated at Clemson University are

presented. The research proposes to determine the significant or key effectiveness measures of the industrial construction materials management process that might be benchmarked within the construction industry.

Text:

Quantitatively measuring the benefit of new concepts and technologies presents a challenge to construction industry professionals. Measurements are key to controlling, managing, and improving any work process. Without measurements, documenting and benchmarking the impact of intentional changes or improvements is limited. Some of these improvements include integrated computer systems, bar coding, and electronic data interchange (EDI). Applying standard measures within the construction materials management process allows current project performance to be benchmarked against past performance, other projects, and possibly other organizations.

Effectiveness, the degree of doing the right things right, evaluates process performance by making a comparison between actual results and planned or target results. Process effectiveness is how well the process meets the requirements of its end customer [3]. Materials management, being a results-oriented process, offers a good candidate for effectiveness measures. In the construction industry, materials and equipment are specified, obtained, and made available to meet the requirements of construction operations, the process customer.

The importance of measuring the degree to which construction's requirements are met by the materials management process identifies the need for applying a results based, or effectiveness, measurement system. Also, measuring the degree to which the materials management process meets the needs and requirements of construction operations allows the impact of process changes to be measured.

The benefits of process improvements like integrated computer systems, bar coding, and EDI have been documented in certain sectors of other industries. Potential gains in profitability and market share prompt investigation into the application of technology and measurement techniques. Adapting existing measurement techniques to the industrial construction environment provides the tools for benchmarking performance measures across functional, project, and organizational boundaries. Benchmarking quantitative measures presents management with the comparative information to justify new technology and measure the success or failure of implementation.

RESEARCH OBJECTIVES

This paper presents the preliminary results of a research effort recently

initiated at Clemson University. The research proposes to answer the following business-related problem: What are the significant, or key, effectiveness measures of the industrial construction materials management process that might be benchmarked within the construction industry?

In answering this question, the aim is to provide the construction industry with appropriate indication of performance for the materials management process that are objectively measurable and yield a hierarchy of measures leading to an overall assessment of effectiveness.

The research has four specific objectives:

* develop industry generic flow diagrams for a typical industrial construction materials management process;

* determine measures, descriptions, units of measure, and measurement points;

* obtain industry consensus in rank ordering the measures; and

* recommend an industry-wide benchmarking mechanism.

METHODOLOGY

The research plan consists of the following tasks.

Literature Review

Examine representative literature and interact with industry professionals to develop a working understanding of effectiveness in relation to the industrial construction materials management process. The result will be documented measures from construction and other industries that evaluate performance of materials management, logistics, or procurement functions.

Flow Chart Development

Develop a generic process model as it applies to materials management for a typical industrial construction project. This model provides the framework for communicating functional boundaries, communication channels for data or information, and measurement points within the system.

Initial Site Visits

Compile a representative group of materials management measures currently used within the industrial construction industry through a number of site visits and inquiries to industry professionals. The feasibility of sharing materials management benchmark data between engineering contractors and facility owners within the construction industry will be investigated. The industry

professionals expressing an interest in participating in the research effort and knowledgeable in their organization's materials management process will be considered to participate on a research advisory team.

Preliminary Measures

Develop a package of representative measures associated with materials management for a typical industrial construction project. The format will include title, definition, measurement points, and illustrative graphics.

Classify Measures

A Delphi technique will be used to classify the measures of materials management effectiveness within five major categories: quality, quantity, cost, time, and availability. A pilot test will be conducted to standardize the survey instrument. Comments resulting from the pilot test and any subsequent investigation may include additional measures, changes in the measurement protocol, or improved graphical samples. The objective is to obtain construction industry consensus on the measurements associated with the five categories.

Rank Ordering of Measures

Determine which measures represent the key measures of materials management effectiveness. The measures within each category will be rank ordered according to the degree to which the measure impacts the defined purpose of the materials management process. A weighted value of importance will be assigned for each measure. Secondary criteria will include the potential for industry-wide process benchmarking.

Analyze the Data

Analysis of the data will identify significant relationships and

industry-specific characteristics. The analysis may include but not be limited to the following:

* identification of the key measures within each major category of effectiveness;

* industry specific relationships among the measures;
* significant differences between the contracting parties (owner, constructor, construction manager); and

* influence of contract type upon the relative importance.

Propose a Benchmarking Mechanism

Based on the input from construction industry professionals, propose a mechanism to communicate effectiveness measures within the construction industry. The preliminary results will be reviewed by a selected group of industry professionals, hereafter called the research advisory team, and the recommendations incorporated into a proposed benchmarking action plan for the construction industry.

THE MATERIALS MANAGEMENT PROCESS

Materials management is the planning and controlling of all necessary efforts to ensure the correct quality and quantity of materials and installed equipment are appropriately specified in a timely manner, are obtained at reasonable cost, and are available when needed [2]. As determined from the literature review, the basic materials management process for a typical industrial construction project is as shown in Figure 1. This functional process model provides a common framework for communicating in common terms within the construction industry. Consequently, the common terminology allows benchmarking partners to communicate key measures of materials management effectiveness across project, functional, and corporate boundaries.

Process and Functional Boundaries

Viewing materials management as a process with interrelated, interdependent, and usually sequential functions provides the basis for developing a process model. The block diagram defines the process and functional boundaries related to a typical industrial materials management process. The arrows represent the material or data flow associated with the primary and secondary suppliers, customers, and functions. For clarity, some contents of the arrows are identified. Separating the functional boundaries allows the individual activities or steps within each function, which may be unique to an organization or project, to be illustrated in a simple, graphical format.

The boundaries allow the identification of the primary and secondary inputs and outputs by imposing a diagramming methodology to be followed. Inputs enter the process and functions through the beginning and upper boundaries. All inputs into the first function must enter through the left or beginning boundary. Inputs for subsequent functions enter through the upper boundaries. Outputs from each function go to secondary customers, while the end boundary identifies the primary output from the process. In the materials management process, the primary output is identified as the issuing of materials to the primary customer, construction operations represented by the craft laborer.

Functional Activities

In the construction industry, the materials management process integrates the functions of planning and scheduling, material

takeoff and design interface, vendor inquiry and evaluation, purchasing, expediting and transportation, field material control, and warehousing. The following descriptions are provided to define the functional boundaries and outline the activities that typically occur within each function:

planning

The planning function contains the activities associated with the establishment of responsibilities by material category and by materials management function, establishment of lines of communication, development of staffing and training plans, and the development of functional plans and procedures. For engineered equipment, equipment lists would be formulated, and milestone schedule, tracking mechanism, and work breakdown structure (WBS) or work packages developed while considering warranties, vendor actions, transportation, storage, and inspection would be formulated. For bulk materials, initial buy and the estimation of quantity and update requirements would be included. Also, the constraints of existing materials, storage, and cash flow would be determined. For prefabricated materials, developing a tag numbering scheme, outlining prefabrication advantages, identifying unique

requirements, and extending controls and communications to the prefabrication site would be considered planning activities.

material takeoff and design interface

This function entails activities related to the project catalog and coding system; the takeoff methods and procedures, determining and consolidating material quantities, identifying craft preferences, and establishing inspection and design change procedures.

vendor inquiry and evaluation

This function contains the activities related to the approved vendor list, capturing vendor performance data and providing performance feedback to the vendors.

purchasing

This concerns the establishment of forms and procedures to purchase materials; developing standard terms and conditions; issuing request for quotations (RFQ); evaluating bids; price and contract negotiation; preparing and administering purchase orders; and executing close out activities, including surplus disposal, addressing claims and backcharges, and records storage.

expediting and transportation

This function is associated with all the activities related to assisting materials vendors with meeting their contractual commitments and providing information regarding material deliveries and vendor data. Other activities

may include performing shop inspections; communicating among design, purchasing, and the work site; executing transportation agreements; performing route surveys; and monitoring transportation status.

field control

This function relates to the activities that execute field procurement; receive arid inspect deliveries; issue materials to the crafts; convey prioritized requirements to expediting; and purchase, receive, issue, and track tools and consumables.

warehousing
This function includes the activities identified with providing of strategic, secure, and organized storage; providing pre-installation maintenance and environmental protection; performing inventories of on-site materials; and the protection and resolution of surplus materials.

Performance Measures

The materials management process exists, either as a formal or informal organizational function, to meet the requirements of construction operations, the process customer. The degree to which customers' requirements are met is a measurable element of process performance. Five indicators of logistical performance are identified as quantity, time, place, quality, and price [6]. Similar terms are so referenced in key statements about the attributes of materials management in construction by Bell and Stukhart [1].

From these two sources, five major categories of effectiveness measures are identified as quality, quantity, cost, time, and availability. These major classifications provide the summary headings for the key effectiveness measures that may be classified or associated with each the following descriptions:

quality
Did we do the "right"' things according to predetermined specifications and plans? Quality is divided into two subcategories--process quality and material quality. Process quality is measured in regards to conformance to established process standards. Examples of process errors would include problems on shipping documentation, warehouse inventory accuracy, and problems with the withdrawal of material. Material quality is the category of effectiveness measures where the nonconformance is manifested in the materials and related to the materials management process.
Examples of material quality would include the percentages of piping spool rework and job-site rejections of tagged equipment.

quantity

Did we get all of the "right" things done? Quantity measures evaluate the process flow or throughput in terms of volume or quantities related to planned accomplishments, for example, the average line items per release, commitment value (home office and field), and min/max activity report

process activity for comparison to average or target values.

timeliness

Did we get the "right" things done on time? These measures report duration aspects of the process. For example, the percentage of bid packages completing the bid/evaluate/commit cycle within established timeframes, the on-time delivery by vendor or material group, or the percentage of material withdrawals or deliveries completed by the need date would evaluate process timeliness.

cost

Did we pay the "right" amount for the things processed? Cost measures can be measured and reported in the representative unit of work hours. Cost measures evaluate the process in terms of meeting planned cost and labor targets. Examples of cost effectiveness include the average work hours per purchase order, percentage of express shipments, construction time lost due to the lack of equipment or materials, the percentage of payments made via electronic fund transfer (EFT and the warehouse safety incident rate.

availability

Do we have things at the "right" place when we planned to have them? Availability measures measure place value. These measures reflect the degree to which the process made the materials and tagged equipment available when construction operations planned to withdraw or receive them. Examples of availability would include the percent of material availability, critical backorders by vendor or material group, and a stockout analysis.

PROPOSED EFFECTIVENESS MEASURES

Current Status within the Construction Industry

Preliminary investigation indicates industry professionals have some notion of what they regard as effective materials management performance. However, the lack of common measures prevents the quantitative evaluation of the materials management process. Also, the potential savings and productivity increases associated with an effective materials management process is a commonly held but largely undocumented opinion. A review of manufacturing industry publications identified the use of standard process methodology and terminology for measuring logistics and procurement functions. However, the construction industry lacks a similar system of measurement and terminology.

Current Measures

Individuals, project organizations, and companies within the construction industry have developed a number of measures for the materials management process. Over half of the following

measures are currently used by a major EPC contractor. The remainder are in use or proposed by construction and facility owner professionals.
The following measures are presented within suggested categories:
quality

* materials receiving problems (process quality);

* warehouse inventory accuracy (process quality) (see Figure 2);

* materials withdrawal problems (process quality);

* piping spool rework (materials quality); and

* jobsite rejection of tagged equipment (materials quality). (Figure 2 omitted)

quantity

* average line items per release;

* percentage of purchase orders from home office;

* percentage of materials purchased via supplier alliances (Figure 3);

* warehouse minimum/maximum activity. (Figure 3 omitted)

timeliness
* average duration of the bid/evaluate/commit (BEC) cycle (figure 4);

* vendor timeliness (by vendor or material group);

* material withdrawal request (MWR) need date lead time; and

* MWR process time. (Figure 4 omitted)

cost

* freight costs;

* expediting costs (express deliveries);

* construction time lost due to lack of equipment or materials (Figure 5); and

* warehouse safety incident rate. (Figure 5 omitted)

availability

* material availability (Figure 6);

* backorders (by vendor or materials group); and
* warehouse stockout analysis. (Figure 6 omitted)

Figures 2 through 6 illustrate four of the measures identified during the preliminary investigation. Figure 2 plots inventory accuracy for the current week and a six-week average over an eight-week period. The trended data provide information on warehouse efforts to support construction operations. A goal of 95 percent availability would suggest a performance level for the warehouse function.

Figure 3 slows management's effort to take advantage of strategic agreements with suppliers. The benefits of these agreements or alliances correspond to the percentage or volume of materials purchased under them. Trending the data quantitatively communicates performance in reaching specific objectives.

Figure 4 illustrates the effect of process changes in reducing the BEC cycle duration. The weekly average BEC duration is plotted over time along with the upper control limit (UCL) and the data average. This information quantifies the impact of process improvements (EDI, bar coding) implemented throughout the time period.

Figure 5 communicates how effectively the

materials
management process is performing to support construction operations. Feedback on the construction time lost due to the lack of engineered equipment or materials captures some of the impact of not meeting schedule requirements. The weekly data can be taken from construction timecards and plotted by week or as part of a six-week rolling average. The UCL is plotted to show the interval of three standard deviations from the average. If the process remains in control, all or almost all of the plotted points should stay within the control limit. If a point falls outside the control limit, it is a warning that the process may be going out of control, and the process owner should begin to look for the cause of the out-of-limits measurement.

Figure 6 shows the percentage of material available when requested by construction for scheduled activities. (Figure 6 omitted) The weekly average for a project can be compared with the monthly industry average to convey a considerable amount of comparative information.

Measurement Points

Each effectiveness measure should be assigned a point in the process where the measurement data are collected. Many of these points are consistent across project and organizational boundaries. Also, many of the points are now being used within productivity and efficiency measurement systems.

Benchmarking within the

construction industry requires a standard
set of measurement points of project data and information. Identifying and

communicating these points is possible by expanding the general materials management process diagram. For example, Figure 7 illustrates an expanded flow diagram for the purchasing function. (Figure 7 omitted) This diagram identifies the typical functional inputs, outputs, suppliers, customers, and communication channels.

To date, 40 measures have been identified and developed as representative measures of the materials management process. The majority of these measures originated from operator/owner and construction organizations. During the pilot test and research process, additional measures may be identified and added to the final results.

BENCHMARKING

Benchmarking is a technique of evaluating performance in specific areas when compared to recognized leaders. Comparisons can be made for similar processes and functions within an organization, or between competitors and non-competitors. Also, benchmarking is a technique to establish a baseline for existing performance of a process in the where subsequent measurement could be compared against to identify trends [4].

Why Benchmark?

Using the data generated and contained within the comprehensive computer systems that facilitate the execution and coordination of the materials management function would allow evaluation of the key effectiveness measures as the work progress. By tracking the results over time, improvement trends provide additional justification for new technologies and management strategies. By recognizing the validity of materials management effectiveness measures across the construction industry, benchmarking communications similar to those benefiting the manufacturing, merchandising, and transportation industries would be possible.

Suggested Benchmarking Process

The American Productivity & Quality Control (APQC) developed an integrated, systematic, measured approach to benchmarking. The APQC approach to benchmarking, hereafter called the APQC model, is suggested as the benchmarking methodology for this research. The APQC model resulted from a survey of 87 member companies and proposes a generic approach to benchmarking that would apply to a wide range of organizations [5].

The APQC model contains four basic steps--plan, collect, analyze, and improve. Planning determines what to benchmark and who to benchmark. Specific actions during this step would include analyzing the process flow and process performance measures, and flow diagramming the process. The collecting step gathers data and information about the process. Specific actions would include collecting internal process data and contacting benchmarking partners.

Analyzing data quantifies the performance gap and identifies the potential

actions necessary to improve performance. Specific actions include normalizing performance to a common base, identify performance gaps and their root cause, projecting performance three to five years into the future, and isolate actions that correlate to process improvements.

The improvement phase transfers the results of the comparisons into improved business processes. Specific actions within this fourth step includes setting goals, developing an action plan, gaining acceptance and ownership of the process changes, committing the resources, and monitoring progress toward the goals.

A Benchmarking Mechanism

A benchmarking mechanism for the construction industry is possible. Suggested is a computer bulletin board system to be maintained by an organization familiar with the needs of the industry.

The Construction Industry Action Group (CIAG), formed in 1992 for the purpose of promoting EDI and related technologies in the US construction industry would be a logical choice as an organization to maintain such a system. Benchmarking partners would regularly communicate their key measures to the bulletin board database. The information would be analyzed for performance highs, lows, and industry averages. Analysis results would be either made available to the participants or communicated by formal report(s). The resources required to maintain a benchmarking clearinghouse would consist of a computer with modem connection, a bulletin board software package, supporting database, and word processing software.

As part of this research, a pilot benchmarking clearinghouse will be configured and tested at Clemson University. The lessons and refinements learned from the pilot implementation will become part of the research deliverables.

Application to the Construction Industry

The physicist Lord Kelvin once said "when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind." By benchmarking key effectiveness measures within the construction industry, management has the necessary means to improve a key business process that can make significant contribution to the cost effectiveness of projects [2]. This ammunition for change presents a significant challenge to the competitive nature of most construction organizations.
Additional motivation to consider benchmarking is found in the criteria given to benchmarking and continuous improvement as part of the Baldrige quality award. Because of the Baldrige criteria, benchmarking and the sharing of information has increased dramatically among various benchmarking partners [5].

CONCLUSIONS

The current status of the research effort combined with the data and

information gathered during four site visits to major construction projects and numerous communications with industry professionals provides the basis for the following conclusions.

* Construction managers do not apply consistent methodologies for measuring and, therefore, controlling the materials management process.

* Key measures of the materials management process exist within the industry. However, these measures are not applied uniformly, nor are they used to compare the effectiveness of the materials management process across project, functional, or organizational boundaries.

* Effectiveness of the materials management process is directly related to the people, methods, and technologies involved in performing specific, but common activities. The results or output of these activities impact, to some degree, how well the "right" things are done to support construction operations.

* The stability of the project environment has a positive influence upon the development and use of measures. One major industrial contractor used the stable environment associated with long-term agreements with the facility owner and materials suppliers to develop quantitative measures for the materials management process. The contractor reports contract performance in terms of several specific measures. Also, these measures quantify the impact of process improvements such as EDI, bar coding, and integrated database technologies.

* Traditional data and information can be reaggregated or combined with other project data to allow performance measurement of the materials management process. The majority of the measurement data appear to be available in project controls and procurement system databases. In addition, performance measurement is supported by information technology that provides the means for applying innovative types of measures and comparisons.

Potentially significant improvement of the materials management process is possible for three reasons. First, defining key effectiveness measures in a standard format provides the common vocabulary for collaboration within the industrial construction industry. Second, collaboration is made possible by the use of a generic functional model of the materials management process. Third, process benchmarking materials management effectiveness date provides the measures to establish targets and an understanding of changes necessary to improve.

The research discussed in this paper proposes to answer the business question and develop a pilot benchmarking mechanism for the construction industry. The anticipated date when results from this research effort will be available is August 994.

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James K. Plemmons, PE Clemson University Dept. of Civil Engineering 131 Lowry Hall Clemson, SC 29634-0911

Dr. Lansford C. Bell, PE Clemson University Dept. of Civil Engineering Clemson, SC 29634-0911

THIS IS THE FULL-TEXT.

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Measuring and benchmarking materials management effectiveness

Abstract:

Quantitatively measuring the benefit of new concepts and technologies presents a challenge to construction industry professionals. Measurements are key to controlling, managing, and improving any work

process. Applying standard measures within the construction materials management process allows current project performance to be benchmarked against past performance, other projects, and

possibly...

...evaluates process performance by making a comparison between actual results and planned or target results. Materials management, being a results-oriented process, offers a good candidate for effectiveness measures. The results of...

...presented. The research proposes to determine the significant or key effectiveness measures of the industrial construction materials management process that might be benchmarked within the construction industry.

Text:

Quantitatively measuring the benefit of new concepts and technologies presents a challenge to construction industry professionals. Measurements are key to controlling, managing, and improving any work process. Without measurements...

...integrated computer systems, bar coding, and electronic data interchange (EDI). Applying standard measures within the construction materials management process allows current project performance to be benchmarked against past performance, other projects, and possibly...

...Process effectiveness is how well the process meets the requirements of its end customer [3]. Materials management, being a results-oriented process, offers a good candidate for effectiveness measures. In the construction industry, materials and equipment are specified, obtained, and made available to meet the requirements of construction operations, the process customer.

The importance of measuring the degree to which construction's requirements are met by the materials management process identifies the need for applying a results based, or effectiveness, measurement system. Also, measuring the degree to which the materials management process meets the needs and requirements of construction operations allows the impact of process changes to be measured.

The benefits of process improvements...

...into the application of technology and measurement techniques. Adapting existing measurement techniques to the industrial construction environment provides the tools for benchmarking performance measures across

functional, project, and organizational boundaries. Benchmarking...

...following business-related problem: What are the significant, or key, effectiveness measures of the industrial construction materials management process that might be benchmarked within the construction industry?

In answering this question, the aim is to provide the construction industry with appropriate indication of performance for the materials management process that are objectively measurable and yield a hierarchy of measures leading to an overall...
...The research has four specific objectives:

* develop industry generic flow diagrams for a typical industrial construction materials management process;

* determine measures, descriptions, units of measure, and measurement points;

* obtain industry consensus in rank...

...with industry professionals to develop a working understanding of effectiveness in relation to the industrial construction materials management process. The result will be documented measures from construction and other industries that evaluate performance of materials management, logistics, or procurement functions.

Flow Chart Development

Develop a generic process model as it applies to materials management for a typical industrial construction project. This model provides the framework for communicating functional boundaries, communication channels for data or information, and measurement points within the system.
Initial Site Visits

Compile a representative group of materials management measures currently used within the industrial construction industry through a number of site visits and inquiries to industry professionals. The feasibility of sharing materials management benchmark data between engineering contractors and facility owners within the construction industry will be investigated. The industry professionals expressing an interest in participating in the research effort and knowledgeable in their organization's materials management process will be considered to participate on a research advisory team.

Preliminary Measures

Develop a package of representative measures associated with materials management for a typical industrial

construction project. The format will include title, definition, measurement points, and illustrative graphics.

Classify Measures

A Delphi technique will be used to classify the measures of materials management effectiveness within five major categories: quality, quantity, cost, time, and availability. A pilot test will...

...measures, changes in the measurement protocol, or improved graphical samples. The objective is to obtain construction industry consensus on the measurements associated with the five categories.

Rank Ordering of Measures

Determine which measures represent the key measures of materials management effectiveness. The measures within each category will be rank ordered according to the degree to which the measure impacts the defined purpose of the materials management process. A weighted value of importance will be assigned for each measure. Secondary criteria will...

...effectiveness;

* industry specific relationships among the measures;

* significant differences between the contracting parties (owner, constructor, construction manager); and

* influence of contract type upon the relative importance.

Propose a Benchmarking Mechanism

Based on the input from construction industry professionals, propose a mechanism to communicate effectiveness measures within the construction industry. The preliminary results will be reviewed by a selected group of industry professionals, hereafter...

...research advisory team, and the recommendations incorporated into a proposed benchmarking action plan for the construction industry.

THE MATERIALS MANAGEMENT PROCESS

Materials management is the planning and controlling of all necessary efforts to ensure the correct quality and...

...cost, and are available when needed [2]. As determined from the literature review, the basic materials management process for a typical industrial construction project is as shown in Figure 1. This functional process model provides a common framework for communicating in common terms within the construction industry. Consequently, the common terminology allows benchmarking partners to communicate key measures

of materials management effectiveness across project, functional, and corporate boundaries.

Process and Functional Boundaries

Viewing materials management as a process with interrelated, interdependent, and usually sequential functions provides the basis for developing...

...model. The block diagram defines the process and functional boundaries related to a typical industrial materials management process. The arrows represent the material or data flow associated with the primary and secondary...

...secondary customers, while the end boundary identifies the primary output from the process. In the materials management process, the primary output is identified as the issuing of materials to the primary customer, construction operations represented by the craft laborer.

Functional Activities

In the construction industry, the materials management process integrates the functions of planning and scheduling, material takeoff and design interface, vendor inquiry...

...function contains the activities associated with the establishment of responsibilities by material category and by materials management function, establishment of lines of communication, development of staffing and training plans, and the development of functional plans and procedures. For engineered equipment, equipment lists would be formulated, and milestone schedule, tracking mechanism, and work breakdown structure (WBS) or work packages developed while considering warranties...

...of on-site materials; and the protection and resolution of surplus materials.

Performance Measures

The materials management process exists, either as a formal or informal organizational function, to meet the requirements of construction operations, the process customer. The degree to which customers' requirements are met is a measurable...

...and price [6]. Similar terms are so referenced in key statements about the attributes of materials management in construction by Bell and Stukhart [1].

From these two sources, five major categories of effectiveness measures...

...of effectiveness measures where the nonconformance is manifested in the materials and related to the materials management process. Examples of material quality would include the percentages of piping spool

rework and job hours per purchase order, percentage of express shipments, construction time lost due to the lack of equipment or materials, the percentage of payments made...

...reflect the degree to which the process made the materials and tagged equipment available when construction operations planned to withdraw or receive them. Examples of availability would include the percent of...

...vendor or material group, and a stockout analysis.

PROPOSED EFFECTIVENESS MEASURES

Current Status within the Construction Industry

Preliminary investigation indicates industry professionals have some notion of what they regard as effective

materials management performance. However, the lack of common measures prevents the quantitative evaluation of the materials management process. Also, the potential savings and productivity increases associated with an effective materials management process is a commonly held but largely undocumented opinion. A review of manufacturing industry publications...

...use of standard process methodology and terminology for measuring logistics and procurement functions. However, the construction industry lacks a similar system of measurement and terminology.

Current Measures

Individuals, project organizations, and companies within the construction industry have developed a number of measures for the materials management process. Over half of the following measures are currently used by a major EPC contractor. The remainder are in use or proposed by construction and facility owner professionals. The following measures are presented within suggested categories:

quality

* materials receiving...

...figure 4);

* vendor timeliness (by vendor or material group);

* material withdrawal request (MWR) need date lead time; and

* MWR process time. (Figure 4 omitted)

cost

* freight costs;

* expediting costs (express deliveries);

* construction time lost due to lack of equipment or materials (Figure 5); and

* warehouse safety incident...

...over an eight-week period. The trended data provide information on warehouse efforts to support construction operations. A goal of 95 percent availability would suggest a performance level for the warehouse...

...improvements (EDI, bar coding) implemented throughout the time period.

Figure 5 communicates how effectively the materials management process is performing to support construction operations. Feedback on the construction time lost due to the lack of engineered equipment or materials captures some of the impact of not meeting schedule requirements. The weekly data can be taken from construction timecards and plotted by week or as part of a six-week rolling average. The...
...out-of-limits measurement.

Figure 6 shows the percentage of material available when requested by construction for scheduled activities. (Figure 6 omitted) The weekly average for a project can be compared...

...the points are now being used within productivity and efficiency measurement systems.

Benchmarking within the construction industry requires a standard set of measurement points of project data and information. Identifying and communicating these points is possible by expanding the general materials management process diagram. For example, Figure 7 illustrates an expanded flow diagram for the purchasing function...

...channels.

To date, 40 measures have been identified and developed as representative measures of the materials management process. The majority of these measures originated from operator/owner and construction organizations. During the pilot test and research process, additional measures may be identified and added...

...and contained within the comprehensive computer systems that facilitate the execution and coordination of the materials management function would allow evaluation of the key effectiveness measures as the work progress. By tracking...

...trends provide additional justification for new technologies and management strategies. By recognizing the validity of materials

management effectiveness measures across the construction industry, benchmarking communications similar to those benefiting the manufacturing, merchandising, and transportation industries would be...

...resources, and monitoring progress toward the goals.

A Benchmarking Mechanism

A benchmarking mechanism for the construction industry is possible. Suggested is a computer bulletin board system to be maintained by an organization familiar with the needs of the industry.

The Construction Industry Action Group (CIAG), formed in 1992 for the purpose of promoting EDI and related technologies in the US construction industry would be a logical choice as an organization to maintain such a system. Benchmarking...

...learned from the pilot implementation will become part of the research deliverables.

Application to the Construction Industry

The physicist Lord Kelvin once said "when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind." By benchmarking key effectiveness measures within the construction industry, management has the necessary means to improve a key business process that can make...

...2]. This ammunition for change presents a significant challenge to the competitive nature of most construction organizations.

Additional motivation to consider benchmarking is found in the criteria given to benchmarking and...

...research effort combined with the data and information gathered during four site visits to major construction projects and numerous communications with industry professionals provides the basis for the following conclusions.

* Construction managers do not apply consistent methodologies for measuring and, therefore, controlling the materials management process.
* Key measures of the materials management process exist within the industry. However, these measures are not applied uniformly, nor are they used to compare the effectiveness of the materials management process across project, functional, or organizational boundaries.

* Effectiveness of the materials management process is directly related to the people, methods, and technologies involved in performing specific, but...

...these activities impact, to some degree, how well the "right" things are

done to support construction operations.

* The stability of the project environment has a positive influence upon the development and...

...term agreements with the facility owner and materials suppliers to develop quantitative measures for the materials management process. The contractor reports contract performance in terms of several specific measures. Also, these measures...

...can be reaggregated or combined with other project data to allow performance measurement of the materials management process. The majority of the measurement data appear to be available in project controls and...

...the means for applying innovative types of measures and comparisons.

Potentially significant improvement of the materials management process is possible for three reasons. First, defining key effectiveness measures in a standard format provides the common vocabulary for collaboration within the industrial construction industry. Second, collaboration is made possible by the use of a generic functional model of the materials management process. Third, process benchmarking materials management effectiveness date provides the measures to establish targets and an understanding of changes necessary to...

...paper proposes to answer the business question and develop a pilot benchmarking mechanism for the construction industry. The anticipated date when results from this research effort will be available is August 994.

REFERENCES

1. Bell, L.C. and Stukhart, G., March 1986. Attributes of Materials Management Systems. Journal of Construction Engineering and Management, Vol. 112, No. 1, p. 14-21.
2. The Business Roundtable. November 1982. Modern Management Systems. Construction Industry Cost Effectiveness Report, A-6, p. 24-29.

3. Harrington, H.J. 1991. Business...

Descriptors:
Construction industry...

...Project management; ...

...Materials management;

Classification Codes:

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?  d s
Set     Items   Description
S1        182   SELECT (MATERIAL? (N2) MANAGEMENT) AND (PROJECT (N2) MANAGEMENT) AND
(TELECOM?? OR INFRASTRUCTUR?? OR CONSTRUCTION) AND MILESTONE? NOT PY>2001
S2        119   RD  (unique items)
S3          5   S S2 AND (TELECOM?? OR BELLSOUTH)
S4         16   S S2 AND (LEAD () TIME)

?  s s2 and milestone (n2) (chang?? or updat?? or revis??)
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          119   S2
      1131829   MILESTONE
     35124268   CHANG??
      9666457   UPDAT??
      3910646   REVIS??
         1852   MILESTONE(2N)((CHANG?? OR UPDAT??) OR REVIS??)
S5          0   S S2 AND MILESTONE (N2) (CHANG?? OR UPDAT?? OR REVIS??)

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Set     Items   Description
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(TELECOM?? OR INFRASTRUCTUR?? OR CONSTRUCTION) AND MILESTONE? NOT PY>2001
S2        119   RD  (unique items)
S3          5   S S2 AND (TELECOM?? OR BELLSOUTH)
S4         16   S S2 AND (LEAD () TIME)
S5          0   S S2 AND MILESTONE (N2) (CHANG?? OR UPDAT?? OR REVIS??)
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Estimated Cost Summary

Project		Client		Charge Code		Searcher		Job		Service Code	User Number
						Scott Jarrett				51	276702
Date		Time		SessionID		Subsession		Subaccount			
02/11/2009		13:21:39		169		8					
Data Base	Dial Units	Access Charge	Print Credit	Types	Prints	Report	Rank	Links	CSS	Total	
9	0.4750	2.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.65	
13	0.3390	1.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.89	
15	0.8850	4.94	0.00	5.56	0.00	0.00	0.00	0.00	0.00	10.50	
16	2.2830	12.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.74	
20	8.4930	10.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.62	
47	0.5460	3.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.05	
75	0.1610	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.73	
88	0.7700	3.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.50	
120	0.1150	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65	
148	3.7980	21.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.19	
180	0.7340	3.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.03	
194	0.4440	1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.20	
262	0.2870	1.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.67	
275	0.3720	2.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.08	
349	1.6840	8.25	0.00	2.16	0.00	0.00	0.00	0.00	0.00	10.41	
484	0.7110	3.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.59	
485	0.2050	1.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.31	
542	0.3030	1.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.38	
610	0.7970	0.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.83	
613	1.1170	1.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.16	
618	0.2030	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	
619	2.2970	2.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.39	
621	1.0170	5.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.67	
636	0.6030	3.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.36	
649	1.1780	6.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.62	
660	0.1550	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	
810	0.1950	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	
813	0.1820	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	
996	7.9630	35.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	35.04	
Sub Totals	38.3120	$140.30	$0.00	$7.72	$0.00	$0.00	$0.00	$0.00	$0.00	$148.02	
Session Totals	227.2550	$725.70		Telecom	$5.31					$738.73	

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(n2) manag??)) not py>2000

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No databases have items, of 512 searched.

Hits File Name

Estimated Cost Summary

Project		Client		Charge Code		Searcher		Job		Service Code	User Number
						Scott Jarrett				51	276702
Date		Time		SessionID		Subsession		Subaccount			
02/11/2009		13:34:49		169		9					
Data Base	Dial Units	Access Charge	Print Credit	Types	Prints	Report	Rank	Links	CSS	Total	
411	39.6660	116.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	116.62	
Sub Totals	39.6660	$116.62	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$116.62	
Session Totals	267.0340	$855.78		Telecom	$3.49					$859.27	

>>>E: No databases were chosen

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